Recycling of Tank Silt for Improving Soil and Water Productivity in Rainfed Areas[1]

Mohammed Osman
Principal Scientist (Agronomy)
Central Research Institute for Dryland Agriculture,
Santoshnagar, Hyderabad – 500 059

INTRODUCTION

In Peninsular India community tank systems are integral part of rural livelihoods for centuries. The interactions between human, land and water are highest in tanks and provides highest productivity both in agriculture and ecosystem uses. Tanks have multiple functions and several outputs like food (fish), fodder (tank bed) and fuel (bushes), ecosystem services like biodiversity (flora, fauna, avian), groundwater recharge and supporting services like washing, bathing, retting, etc. Tanks serve as a common pool resource and have various stakeholders ranging from government agencies, local *panchayat*, farmers, rural rich and poor. The breakdown of traditional system has resulted in encroachment, siltation, weed growth and poor inflows. Over exploitation of groundwater through bore wells have made these water bodies as a neglected entity, truly as "tragedy of commons". Poor management practices of catchment have resulted in silting of most of these water bodies and significant reduction of storage capacity. Silt deposit has not only reduced the storage capacity but also groundwater recharge, eutrophication of tanks and most importantly higher release of carbon to atmosphere through silt mediated anaerobic decomposition of organic carbon. Good practices such as desilting and application of silt to agricultural fields have been abandoned. Continued mining by crops and reduced application of organic manures has resulted in deficiency of several nutrients particularly that of micronutrients. Recycling of tank silt provides a win-win situation to both, improvement in soil health and renovation of the tank.

PILOT STUDY

The pilot study has been carried out in collaboration with Modern Architects of Rural India (MARI) a NGO active in Warangal, and ICRISAT in Andhra Pradesh, and was funded by World-Wide Fund for Nature (WWF). The geographical area of the Warangal district is 12846 sq. km. About 41% of total area is under cultivation, while 29% is under forest. Current and other fallow account for about 15% and the rest 15% is under miscellaneous category (non-agricultural, barren, grazing land, cultivable waste, etc.). All the mandals receive about 1000 mm rainfall mainly through S-W monsoon. The study was carried in four mandals of the district, which has high percent of cropped area under irrigation namely Nalabelli, Parkal, Shayampet and Regonda through tanks and open dug/bore wells.

The district falls in the catchment of both Krishna and Godavari rivers, two important rivers of Andhra Pradesh. Salivagu micro basin of Godavari river having 447 tanks spread over 878.35 sq km of catchment was selected for this study. Twelve tanks were identified in the Salivagu micro basin for de-silting on pilot basis during 2005-

[1] Lecture Notes for the Winter School on "Technological Advances in Conservation of Natural Resources in Rainfed Agriculture" during November 26 to December 16, 2008, Central Research Institute for Dryland Agriculture, Hyderabad

06. Name of the village, tank and the number assigned to the tank is set out in (**Table 1**) and the number is referred in the figures.

Table 1 Tank number, name of the village, tank and mandal

Tank number	Name of the village	Name of the mandal	Name of the tank
T1	Koppula	Shayampet	Pedda cheravu
T2	Relakunta	Nallabelli	Tummala cheravu
T3	Rudragudem	Nallabelli	Yerra cheravu
T4	Chinnakodepaka	Regonda	Pedda cheravu
T5	Gorikothapalli	Regonda	Bokki cheravu
T6	Gangirenigudem	Shayampet	Thimmanakunta
T7	Nizampally	Regonda	Reddy cheravu
T8	Pathipaka	Shayampet	Moggulacheravu
T9	Dammanapet	Regonda	Pedda cheravu
T10	Rayaparthi	Parkal	Oora cheravu
T11	Repaka	Regonda	Oora cheravu
T12	Munchupla	Nallabelli	Venkatapalem cheravu

Samples of tank silt were drawn using 5.0cm core from four layers (0 to 30cm, 30 to 60cm, 60 to 90cm and 90-120cm) at various locations in the tank bed area proposed for de-silting. Various chemical parameters of silt were assessed using standard methods, data pooled over four depths are set out in **Table-2**.

Table 2 Chemical properties of tank silt

Village name & Tank number	pH	EC (dS/m)	Org.C (%)	Kjhel-N (mg kg^{-1})	Ols-P (mg kg^{-1})	Exch-K (mg kg^{-1})	Avail-S (mg kg^{-1})	Avail-Zn (mg kg^{-1})	Avail-B (mg kg^{-1})
Koppula (T1)	8.0	0.1	0.4	412.0	12.3	431.7	4.6	0.9	0.5
Relakunta (T2)	6.5	0.3	0.5	695.0	27.5	522.0	30.1	5.1	0.4
Rudragudum (T3)	8.5	0.4	0.3	327.8	7.0	271.1	11.9	1.2	0.8
Chinnakodepaka (T4)	8.2	0.2	0.5	533.0	6.3	496.3	18.4	1.1	0.5
Gorikothpally (T5)	7.8	0.2	0.6	515.8	12.8	395.9	15.4	5.6	0.5
Gangrirenigudum (T6)	8.3	0.3	0.5	526.8	16.5	470.9	21.7	0.9	0.7
Nizampally (T7)	7.8	0.1	0.5	409.8	4.8	289.2	6.7	2.2	0.4
Pathipaka (T8)	8.0	0.7	1.5	408.0	8.3	432.2	37.9	0.8	0.5
Dammanapeta (T9)	7.4	0.2	0.4	505.5	29.3	445.9	11.2	1.6	0.5
Rayaparthi (T10)	7.8	0.2	0.4	409.3	35.3	430.2	13.2	0.7	0.4
Repaka (T11)	7.9	0.2	0.5	541.8	12.5	529.7	13.8	0.9	0.6
Munchupla (T12)	7.0	0.2	0.8	747.8	13.5	411.9	24.0	1.8	0.5

The economic valuation of nitrogen in the silt is based on the cost of urea while phosphorous on the basis of single super phosphate (SSP). Potassium based on Muriate of Potash (MOP), Zinc (Zinc Sulphate) and boron (Borax) at the existing rates. Value of tank silt is based on the content of N, P, K, Zinc and Boron and equated with cost of fertilizers. Benefit was calculated by totaling the value of silt for different nutrients. Sulphur was not accounted as SSP and Zinc sulphate supply sulphur. Value of other nutrients was not estimated. The benefit-cost ratio calculated is the apparent value and indicates only the cost of desilting operation borne by the project and the total value of the nutrients.

IMPACT ON SOIL

The clay content of the tank silt ranged from 60 % to 80% while its application to the field reduced the bulk density of the soil from 1.5 to 1.25 g cc^{-1}. Addition of tank silt @ 50, 100, 150 and 375 tractor loads per hectare improved the available water content by 0.002, 0.007, 0.012 and 0.032 g g^{-1} soil, respectively. All the farmers are in agreement that the moisture retention has gone up by 4 to 7 days, which play an important role during the period of prolonged dry spells. This is confirmed through gravimetric studies that the available water content in the root zone increased by one per cent, i.e., from a normal 6% to 7% with addition of 100 tractor loads per hectare. Farmers do believe that once applied the impact on crop yield will remain for three years but the invisible aspect is the permanent change in soil physical and chemical properties. A change in clay percent was noticed from 20 to 40 percent in the root zone while no change in silt content. A decrease in coarse sand and fine sand was noticed. No change in pH, EC and organic carbon was noticed while an appreciable change was observed in available N, P and K and moderate reduction in sulphur. Improvement in clay content will not only retain higher moisture but will also reduce the losses of nutrients through leaching because of improved cation exchange capacity (CEC).

IMPACT ON CROP GROWTH AND YIELD

In an observation made on plant population and growth of rabi maize 45 days after sowing (DAS) indicated that not only silt received plot had higher plant population but also higher plant height (**Fig. 1**). Most of the farmers interviewed reported savings on fertilizers ranging from Rs. 2500/- to Rs. 3750/- per hectare in case of cotton which is the major crop grown in this area. The increase in yield of cotton was to the tune of 1000 kg ha^{-1}. Farmers could achieve this kind of response with application of 100 tractor loads per hectare. Farmers paid Rs.50-60 for each trip of tractor depending upon the distance plus Rs. 10/- towards contribution. A farmer for 100 tractor loads paid Rs. 6000/- towards transport and contribution while the project borne the rest Rs. 6000/- towards desilting. The maximum benefit was obtained in chillies and cotton and the gain was negligible in turmeric and no gain was observed with maize (**Fig. 2**). An additional environmental benefit was obtained through less use of pesticides through application of tank silt. Farmers reported less number of sprays in various crops that received tank silt (**Fig. 3**). The number of sprays reduced by two compared to the normal, which resulted in saving of Rs. 2500 ha^{-1} in cotton, chilli and turmeric while Rs. 1750 ha^{-1} in maize.

ECONOMIC EVALUATION

The economic viability of such investment costs was estimated in order to check the feasibility of silt removal and it's recycling. The quantity of silt removed from different tanks amounted to 76393 tons. The total cost incurred on removal of silt amounted to Rs. 11,33,190/-. The value of silt was quantified in terms of fertilizer equivalent costs for different nutrients. The nutrients retrieved from silt were considered to be the profit (benefit) as against the expenditure (cost) incurred on removing the silt from the tanks. Additionally the process of silt application to farm lands that is rich in organic C will result in C mineralisation and higher nutrient availability thereby helping plant growth and greater fixation of C through photosynthesis.

The benefit-cost ratio was found to be highly variable and ranged from 0.44 to 1.11 (**Table-3**). Average benefit-cost ratio of 0.72 is not reflecting the true picture as physical and other ecosystem benefits are not accounted. It is worth noting that fertilizers are supplied at 50% of the production cost and the government meets the rest as subsidy. If subsidy is accounted the average B:C ratio will become 1.44 and recycling of silt back to the farm lands will become highly economical proposition. Indirect benefits are many and difficult for accounting in rupee terms. Application of silt back to the agricultural fields forms an improved agricultural management practice that enhances and protects the soil quality resulting in improved production capacity of soil and reverses the process of land degradation. The impact of recycling will be long lasting and need to be studied for longer period.

Table 3 Economic valuation of tank sediment in terms of plant nutrients returned to farm and benefit-cost analysis of desilting operation

Name of village and tank	Quantity (tonnes)	Amount spent (Rs.)	Nutrients in terms Rupee equivalent						B:C ratio
			N	P	K	Zinc	Boron	Total	
Koppula	4478	59700	20903.1	2711.8	17931.9	479.6	801.6	42828.0	0.72
Relakunta	7034	93780	55388.2	9523.8	34059.1	4268.9	1007.3	104247.3	1.11
Rudragudum	14184	189120	52679.0	4888.4	35668.8	2025.5	4062.3	99324.1	0.53
Chinnakodepaka	7853	104700	47423.4	2435.8	36152.7	1028.0	1405.7	88445.6	0.84
Gorikothpally	11356	151410	66364.6	7156.6	41703.4	7567.6	2032.7	124825.0	0.82
Gangrirenigudum	1355	18060	8087.5	1100.8	5918.7	145.1	339.6	15591.7	0.86
Nizampally	7538	100500	34999.2	1781.4	20221.6	1973.4	1079.4	60055.1	0.60
Pathipaka	4084	54450	18878.9	1668.9	16376.9	388.8	731.0	38044.5	0.70
Dammanapeta	2100	50400	12027.4	3029.4	8686.0	399.8	375.9	24518.5	0.49
Rayaparthy	3713	89100	17218.6	6453.2	14816.9	309.3	531.7	39329.6	0.44
Repaka	4938	118500	30312.4	3039.0	24262.8	528.9	1060.7	59203.8	0.50
Munchupla	7760	103470	65747.2	5157.9	29649.3	1662.2	1389.0	103605.6	1.00
Average									0.72

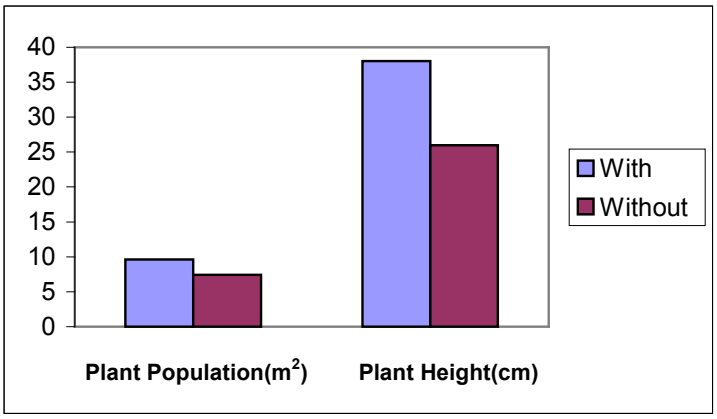

Fig. 1 Impact of silt on plant height and population of maize

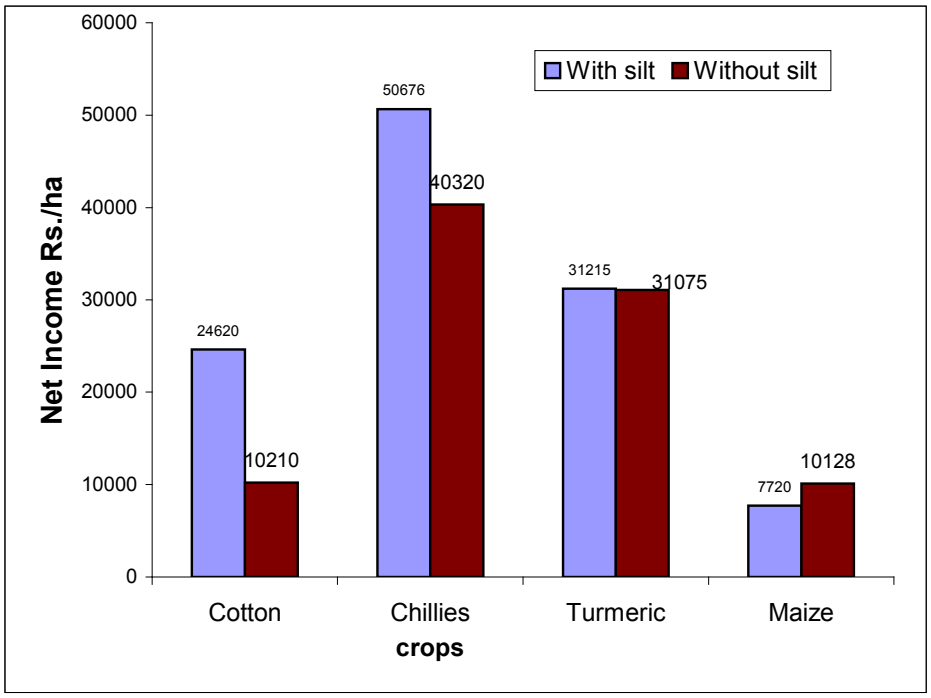

Fig. 2 Net income with and without application of tank silt obtained for various crops by farmers in Warangal district of Andhra Pradesh

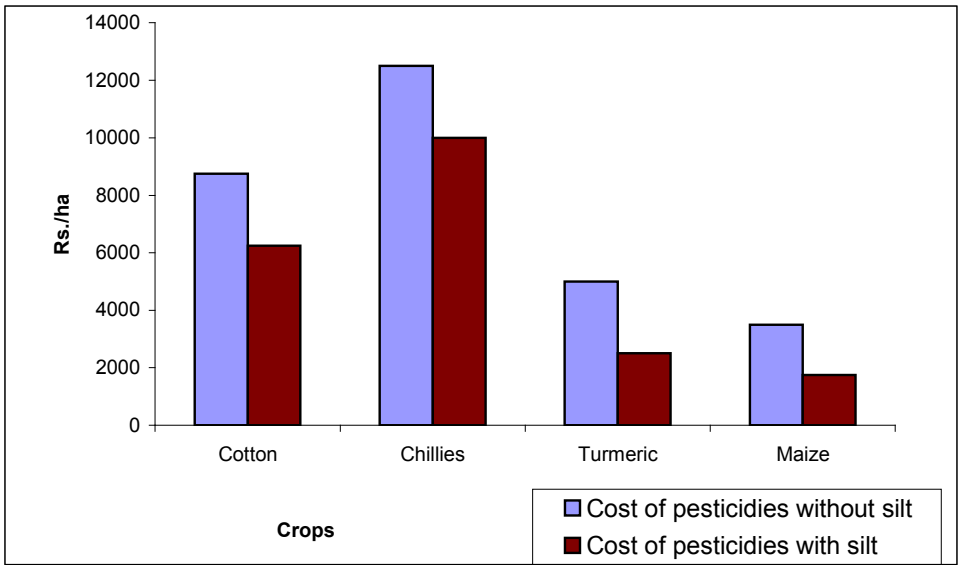

Fig. 3 Savings on pesticides with application of tank silt in various crops

CONCLUSION

In the budget of 2007, Union Minister of Finance has announced 100% subsidy for water harvesting by small farmers and 50% for others. The subsidy needs to be extended to the existing water harvesting bodies for desilting operation, which are defunct because of sediment deposit. Further, the desilting and maintenance activities need to be linked to on-going National Rural Employment Guarantee Act (NREGA) programmes. Also possibility exists for diverting some of the subsidy extended to fertilizer companies to tank desilting operations as silt provides all the nutrients needed by the crop unlike fertilizers, which provide one or two to three at the most. The idea of silt loan analogous to crop loan has been mooted by farmers in a pilot study on de-silting conducted in Warangal district of Andhra Pradesh (Osman et.al, 2007). Thus, there is a need to have renewed focus on traditional wisdom of tanks for rehabilitating water bodies for rainwater harvesting to mitigate frequent droughts and floods attributed to climate change. Tanks ensure equity, groundwater sustainability, trap valuable sediment for recycling and thus, play an important role in enhancing productivity and profitability from rainfed agriculture.

Reference

Osman, M., Ramakrishna, Y.S. and Shaik Haffis. 2007 "Rejuvenating Tanks for Self-Sustainable Rainfed Agriculture in India" *Agriculture Situation in India*, Vol. (LXIV): 67-70